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PHYSIOLOGICAL ACTIVITY IN AN ATTRIBUTE LEARNING TASK

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The relationship between the amount of information processing in an Attribute Learning task and autonomic activity, measured by skin conductance response (SCR), was investigated. The amount of information processing was manipulated by type of concept and feedback. Furthermore, the influence of practice and verbalization was studied.

Three types of concepts were used: conjunction, exclusion and joint denial. The stimulus population consisted of four three-valued dimensions. The results showed that (1) SCR did not differ among concepts; (2) SCR varied with type of feedback, it being smallest at blanks and largest at infirming feedback; (3) SCR was related to the number of confirmations preceding infirmation; (4) subjects mainly used the strategy 'reject hypothesis only after infirmation'; (5) subjects usually selected not-yet-tested hypotheses; (6) practice influenced performance; (7) verbalization did not result in more efficient use of information; however, the appropriateness of the experimental set-up to study this factor was questioned; (8) conjunction was easier to learn than the other concepts. The results were discussed in terms of uncertainty reduction, resulting from testing hypotheses in a concept learning task.

1. Introduction

In many (deterministic) concept learning tasks subjects are required to classify stimuli into two or more categories according to some principle or concept; they are instructed about the characteristics of the stimuli. The concepts consist of two components, the (relevant) stimulus attributes and the rule relating those attributes. Three types of tasks are distinguished: (a) the subject is only informed about the rule (Attribute Learning); (b) the subject is only informed about the relevant attributes (Rule Learning); (c) the subject is neither informed about the

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rule nor about the relevant attributes (Complete Learning). During task performance the subject is informed about the correctness of his classification (further called feedback). For the purpose of the present study three kinds of feedback are distinguished: (a) confirming feedback, that confirms the classification of the subject; (b) infirming feedback, that disconfirms the classification of the subject; (c) noninformative feedback, that gives no information about the classification (further called a blank).

Stimulus-response associationists as well as mediated associationists account for concept learning in terms of associations between the response that is reinforced, and the common features of the instances of a category. Others state, however, that subjects are testing hypotheses during a concept learning task. Accordingly, Levine (e.g. 1975) predicted that subjects change their hypotheses only after infirmative feedback, and not after a confirmation or after a blank. This prediction has been confirmed many times (e.g. Levine 1966; Aiken et al. 1972; Coltheart 1973; Levine et al. 1975; De Swart and Das-Smaal 1976).

Given that subjects are testing hypotheses and change their hypothesis only after infirmation during a concept learning task, different kinds of feedback should result in (a) different amounts of uncertainty reduction about the hypotheses and (b) different information-processing activities. After an infirmation a subject is certain that the hypothesis under test was wrong; thus, he has to reject the hypothesis and select a new one. After confirmation subjects would not have reason to change the hypothesis under test; however, their confidence in such hypotheses increases as a function of the number of confirmations (Trabasso and Bower 1968; Falmagne 1970). The relationship between confidence and number of confirmations is also in agreement with the prediction of Bayes' theorem, a model frequently employed in the area of opinion revision (e.g. Slovic and Lichtenstein 1971; De Swart 1972). A blank does not provide the subject with information; hence, in accordance with Levine, the subject does not have to change his hypothesis nor his uncertainty about it. On the contrary, Spence (1970) stated that a "blank has as much information value concerning response correctness as the overt reinforcer for which it stands" (p. 328). Spence found that subjects treat blanks as signalling correct responses. Hence, according to Spence, blanks and confirmations are expected to be identical in informational value. The first aim of the present study was to investigate this controversy between Levine and Spence by using the skin conductance response (SCR) as independent variable.

Frequently, differences in information processing, perceptual or cognitive, are found to be accompanied by different patterns of autonomic physiological activity (e.g. Pishkin and Wolfgang 1964; Pishkin and Shurley 1968; Zimmermann 1971). De Swart and Das-Smaal (1976) (excluding some methodological shortcomings in these studies) found in a Complete Learning task (in which subjects knew in advance that only a conjunction and an exclusive disjunction were possible) and using SCR as an index for autonomic physiological activity, that SCR was greater after infirmation than after confirmation. Given this result, it is predicted from Spence's (1970) theory that SCR after a blank will not differ from SCR after confirming feedback. However, according to the strategy "reject hypothesis only after infirmation" SCR after a blank should be smaller than after confirming feedback because of the difference in informational value.

In the study of De Swart and Das-Smaal (1976) it was also found (a) that SCR increased with increasing difficulty of the conceptual rule and (b) that SCR at infirming feedback increased with the number of previous confirmations. The latter finding was in accordance with Trabasso and Bower (1968) and Falmagne (1970) and was interpreted in terms of Sokolov's (1969) model of the orienting reflex, which predicts an increasing SCR with increasing discrepancy between the expected and the actual situation. Sokolov employed Bayes' theorem to evaluate at the neural level "the change in the probabilities of the hypotheses as a result of distinct signs which occur from an object" (1969; p. 688).

De Swart and Das-Smaal's (1976) result that SCR was larger after infirmation than after confirmation could not be unambiguously ascribed to a difference in uncertainty reduction alone. An explanation is possible either in terms of differences in uncertainty reduction, or in terms of differences in information-processing activities, resulting from each type of feedback, or both. The same holds for the difference in SCR between the conjunction and exclusive disjunction, which could have been caused by a difference in information-processing activities, resulting from the difference in degree of difficulty between the two rules. An explanation in terms of differences in uncertainty reduction between the conceptual rules is, however, also possible. De Swart and Das-Smaal (1976) found that the two conceptual rules do not have a uniform subjective probability distribution: the prior probability of selecting a conjunctive hypothesis was higher than the probability of selecting an exclusive disjunctive hypothesis. If SCR primarily indicates uncertainty reduction, then differences in SCR among rules must disappear when differences in prior probabilities between the different rules are equated. This prediction was tested in the present study, using an Attribute Learning task, by which uncertainty about the rules was cancelled out. Three different rules were employed: conjunction, exclusion and joint denial. Haygood and Bourne (1965) found for an Attribute Learning task that joint denial was more difficult to learn than conjunction; exclusion was not investigated in that study.

Two other sources, influencing the performance in concept learning tasks, were studied in the present experiment: the effect of practice and verbalization.

De Swart and Das-Smaal (1976) found that in only 2% of the cases subjects changed their hypothesis after confirmation, whereas after infirmation they changed to an other hypothesis in 97% of the cases, and of these 88% had not yet been tested. This result is in accordance with Levine (1966). Coltheart (1973) also found a similar result with repect to infirming feedback, but in her experiment hypotheses were changed after 23% of the confirmations. She supposed that the discrepancy between her data and Levine's partly reflects the difference between practiced and unpracticed subjects, a suggestion supported by White (1974) who found that trained subjects are more apt to use the strategy "reject hypothesis only after infirmation". In the abovementioned study by De Swart and Das-Smaal (1976), however, unpracticed subjects were found to apply this strategy quite consistently. Nonetheless, in accordance with Coltheart (1973), it is hypothesized that the strategy should be applied more consistently with increasing practice. If practice is the only factor which influences consistent use of the strategy, the effect of practice should show up, independent of the conceptual rule in the learning task. This prediction was tested in the present study.

Karpf and Levine (1971) did not find a difference in performance between Levine's blank procedure used to identify the hypothesis held by the subject and verbalization of the hypothesis by the subject himself. Dominowski (1973), however, proposed that overt verbalization of the hypothesis leads to a more efficient use of the available information. The present study investigated the effect of verbalization of the hypothesis. In accordance with Dominowski's (1973) position it is predicted (1) that verbalization leads to faster problem solving (a smaller number of trials to criterion) and (2) that SCR will be smaller in the case of non-verbalization than in case of verbalization because of a less efficient use of the information. From Karpf and Levine's (1971) study such differences in number of trials to criterion and in SCR are not predicted.

2. The experiment

2.1. Task

Three Attribute Learning tasks were employed which required the learning of a conjunction (TT), an exclusion (TF) and a joint denial (FF). Each *S* received three problems, each representing one type of task. The *S*s were divided into three groups corresponding to three orders of presentation: TT, TF, FF; TF, FF, TT; FF, TT, TF.

Within each group half the *S*s received feedback on each trial (100%), the other half received feedback in 67% of the cases (67%).

Within each of these six groups one half of the *S*s had to verbalize their hypothesis (V), the other half were not requested to state their hypotheses ($\overline{\mathrm{V}}$). The tasks were terminated for the verbalization group either when *S* had correctly classified five successive stimuli and mentioned the correct concept or, if this did not occur, after 40 trials. The criterion to terminate a task for the non-verbalization group was eleven successive correct classifications or after 40 trials.

2.2. Subjects

Twenty-four female and twenty-four male *S*s participated in the experiment. Twelve female and twelve male *S*s were psychology freshmen, whose participation was considered part of their training. The other half of the *S*s were student volunteers, who were paid Dfl. 10.00 (about $4.00) per hour for their participation.

2.3. Stimulus material

The stimulus material consisted of slides showing geometrical figures. Four three-valued dimensions were used. Each slide contained one value of each dimension: shape (square, circle or diamond), shading within the shape (horizontal, vertical or diagonal), location on the slide (high, middle, low), and sign (+, –, X) in the middle of the shape. Thus, the stimulus population consisted of 81 different slides.

The feedback slides showed the words 'positive', 'negative' or 'unknown'.

2.4. Apparatus

The experimental room was dimly illuminated and soundproof. A projector (Carousel Model Type 2) was located outside the room. Stimuli and feedback slides were projected on a frosted glass window in front of *S*. Next to the window a card was suspended, showing the code which *S*s had to use when formulating their hypotheses about the concept. *S*s who had to state their hypotheses aloud, did so via a microphone. Their hypotheses were written down by the experimenter. Stimuli had to be assigned to one of two response categories: the positive or the negative category. *S*s had to give their categorization responses by pressing one of two buttons, a positive or a negative one. These were fixed to the arm rest of *S*'s chair within the reach of his preferred hand. Responses were recorded automatically with the aid of a Beckman 8-channel polygraph (type R 411 dynograph).

Timer impulses to the projector and the SCR were also recorded on this polygraph. Basic level SCR was measured DC and specific SCR's were measured AC by a constant 0.5 V voltage bridge. AC responses were registered with a time constant of 3 sec. Ag/AgCl-electrodes, 7.5 mm in diameter, were attached to the volar surface of the distal phalanx of the second and third finger of the *S*'s nonpreferred hand. Agar-agar paste with a 0.067 M KCl solution was used.

2.5. *Procedure*

After informing *S* about the experimental equipment, the recording leads were attached and *S* was seated in the soundproof room. Sample slides were shown containing each of the dimensional values at least once. Then *S* was given instructions as to the nature of the task, the responses required, and the meaning of the feedback. In the 67% feedback condition *S*s were told that two types of feedback would be given, with information (positive or negative) and without information (unknown). It was explained that the latter type of feedback contained no information about the correctness of *S*'s response. A training task was given followed by five minutes rest. Then the three experimental tasks were presented in succession, separated by rest-intervals of approximately three minutes duration. Each task was terminated at criterion. At the beginning of each task *S* was told which conceptual rule was applicable.

The trials of the experimental tasks were composed as follows: stimulus presentation (12 sec), after which *S* had to give his categorization response (plus or minus) immediately; seven sec after the stimulus offset, feedback (positive, negative or unknown) was shown during five sec. After a five sec rest interval, the verbalization *S*s had to state their hypothesis about the concept. This had to be done within 13 sec, which was indicated by a green light. Then, after a further interval of four sec, the next stimulus was presented. Following the feedback, the non-verbalization group was given six sec rest, after which the next stimulus was shown.

The order of presentation of the stimuli within each task was the same for each *S*. But each task had a different order. This order was determined at random, with the following restrictions: (1) only one value in the stimulus sequence would change at a time; (2) 50% of the presented stimuli were instances of the concept; (3) in the 100% as well as the 67% feedback condition the order of the feedback slides was the same for each of the three tasks; (4) and for an optimal information processor the sixth trial of each task reduced the number of possible hypotheses to one. In the 67% feedback condition, the blanks and the positive and negative feedback appeared equally often.

For each task, independent groups received different problems constructed to employ each dimension at least once. Two different problems were used for each task.

2.6. Quantification of data

SCR was measured as the greatest conductance change (ΔSC), beginning between one and four sec after the onset of the feedback. To reduce individual differences in SCR reactivity the change in log conductance (Δ log C) was calculated and taken as a measure for the SCR.

Dependent on the response (and hypothesis for the verbalization group) of the *S*, different types of feedback were distinguished; in the 100% condition: confirming and infirming feedback; in the 67% condition: confirming, infirming and no feedback.

The data were processed by means of ANOVA. A consequence of the number of blank trials in the 67% condition was, that *S*s received a maximum of 27 trials per problem, i.e. trials from which they could learn, instead of a maximum of 40 trials as indicated by the criterion. Hence number of trials to criterion (TLE) and number of errors (NE) were based on 27 trials at most, excluding the blanks. All analyses involved factorial designs, in which the factor '*S*s' was treated as a random effect, and all other factors were treated as fixed effects. Differences between the means were evaluated by means of Duncan's new multiple range test (Edwards 1960).

3. Results

In a previous analysis no differences between paid and unpaid *S*s turned up, therefore the data were not further analyzed with respect to this variable. Table 1 summarizes the means of each dependent variable for the main sources.

3.1. Trials to criterion and number of errors

The number of *S*s who did not solve the problem within 27 learning trials, were 2, 15 and 20 for TT, TF and FF, respectively. TT differed significantly from TF and FF (Cochran Q test; $Q = 19.88, p < 0.001$; $Q = 29.45, p < 0.001$, respectively); TF and FF did not differ significantly (Cochran Q test; $Q = 1.43, p > 0.05$).

Columns 1 and 2 of table 1 show trials to criterion (TLE) and number of errors (NE), respectively. TLE and NE were highly correlated ($r = 0.85, p < 0.001$). From all sources and interactions only Tasks yielded a significant F value for TLE ($F(2,48) = 15.77, p < 0.001$) as well as for NE ($F(2,48) = 25.02, p < 0.001$); TT was significantly lower than TF and FF ($p < 0.01$), whereas TF and FF did not differ significantly ($p > 0.05$).

An ANOVA based on a maximum of 40 trials (NE in the 67% condition included the blanks) resulted in a significantly higher NE in the 67% than in the 100% condition ($\bar{X} = 8.69$ and $\bar{X} = 6.47$, respectively; $F(1,24) = 5.23$, $p < 0.05$) and a nearly significant difference in the same direction in TLE between the two conditions ($\bar{x} = 20.26$ and $\bar{x} = 15.74$, for 67% and 100%, respectively; $F(1,24) = 3.65$, $p =$

Table 1
The mean values of the main effects for each of the dependent variables.

Main sources	Dependent variables		Skin conductance response	
	Trials to criterion	Number of errors	100%	67%
Verbalization				
V	13.40	5.90	34.97	31.81
$\bar{V}$	13.74	5.04	45.44	44.80
Percentage of feedback				
67%	12.51	5.43	38.04	–
100%	14.63	5.51	42.38	–
Order of presentation				
TT, TF, FF	14.73	5.90	34.56	40.71
TF, FF, TT	13.29	5.29	41.46	32.83
FF, TT, TF	12.69	5.23	44.60	41.38
Sex				
male	14.06	5.54	41.25	39.62
female	13.08	5.40	39.17	39.99
Type of feedback				
blank	–	–	–	28.19
confirmation	–	–	38.45	36.99
infirmation	–	–	48.53	49.74
Tasks				
TT	7.27	2.48	36.92	36.82
TF	15.40	6.08	40.38	36.20
FF	18.04	7.85	43.33	41.90

0.07). This was a plausible result, for the 67% condition provided less information than the 100% one, hence more learning trials were necessary and the probability of making an error was higher in the 67% than in the 100% condition.

In 96% of the trials *S*s behaved according to the optimal strategy 'reject hypothesis only after infirmation'. Following a confirmation a new hypothesis was selected in 2%, and following a blank in 14% of the cases, whereas following an infirmation, the hypothesis was altered in 91% of the cases. *S*s applied the optimal strategy less consistently in the first task than in the other two tasks; 46% of the inconsistencies were made during the solution of the first task.

3.2. Skin conductance response

The overall ANOVA did not show any significant SCR differences among V and $\bar{V}$, 100% and 67%, the different orders of presentation, sexes and tasks. The data yielded a significantly higher SCR at infirming than at confirming feedback ($F(1,24) = 13.55$, $p < 0.001$). An analysis within the 67% condition resulted in a significant difference among no (blank), confirming and infirming feedback ($F(2,24) = 14.98$, $p < 0.001$); SCR at a blank was significantly lower than at confirmation ($p < 0.05$), which was in turn significantly lower than at infirmation ($p < 0.01$).

The overall ANOVA resulted in several significant interactions with Sex; Verbalization X Sex ($F(1,24) = 6.89$, $p < 0.05$), Type of feedback X Sex ($F(1,24) = 4.49$, $p < 0.05$) and Verbalization X Type of feedback X Sex ($F(1,24) = 4.28$, $p < 0.05$). In the ANOVA within the 67% condition Verbalization X Sex turned out to be significant ($F(1,12) = 9.47$, $p < 0.01$) as well as Verbalization X Type of feedback X Sex ($F(2,24) = 3.70$, $p < 0.05$).

These significant interactions resulted from a difference in performance of men and women with respect to the verbalization variable. Within the 67% condition women reacted with a higher SCR during the V than during the $\bar{V}$ condition, whereas men reacted in the opposite direction. Furthermore, within the 100% condition only the women showed the tendency toward a lower SCR at confirmation than at infirmation. Within the 67% condition both sexes showed the overall effect of a lower SCR after confirmation than after infirmation.

The only other significant interaction turned out to be Order of presentation X Tasks ($F(4,48) = 6.69$, $p < 0.01$), which interaction actually deals with the order in which the concepts were learned. Learning a concept later in the experimental session resulted in a smaller SCR value ($p < 0.01$; $\bar{X}_1 = 57.05$, $\bar{X}_2 = 40.09$, $\bar{X}_3 = 33.32$). This tendency held for TT and FF, but not for TF; SCR during learning the second concept was smaller than during learning the third one, but both SCR values were smaller than during learning the first concept. Hence, it was concluded that the decrease of SCR during the experiment resulted from habituation.

The effect of habituation was further analyzed by vincentizing each of the tasks (in equal parts for each *S*) to correct for the difference in number of trials between *S*s. SCR decreased significantly throughout TT and FF, but not during TF (Friedman two-way analysis of variance; $\chi^2 = 22.87$, $df = 2$, $p < 0.001$; $\chi^2 = 4.14$, $df = 2$, $p < 0.05$; $\chi^2 = 2.57$, $df = 2$, $p = 0.12$, respectively).

The lack of difference in SCR between tasks could have been caused by habituation because of the different number of trials required for solution. Therefore, the same number of trials for each task was analyzed by using the number of trials of the task with fewest trials. This analysis showed a tendency for SCR to be smaller during TT than during FF (sign test; $0.05 < p < 0.10$); the other comparisons (TT–TF and TF–FF) did not reach significance. Correlations between SCR and number of trials yielded a trend toward a positive relationship only for TT ($r_s = 0.19$; $p = 0.09$); the other correlations were not significant.

To determine the relationship between the number of previous confirmations of a hypothesis and SCR after infirmation of that hypothesis, the SCR data within the V condition were classified into four categories in accordance with the number of directly preceding confirmations of a hypothesis (0, 1, 2 and ≥ 3). SCR turned out to increase with increasing number of confirmations before infirmation within the 100% condition, but not within the 67% condition (Friedman two-way analysis of variance; $\chi^2 = 20.55$, $df = 3$, $p < 0.001$; $\chi^2 = 1.66$, $df = 3$, $p > 0.10$, respectively).

4. Discussion

From Levine (1975) it was predicted that, if subjects perform in accordance with the optimal strategy 'reject hypothesis only after infirmation', their hypothesis testing behavior following a blank or confirmation should not differ. However, blanks and confirmations should differ with respect to their informational value. With respect to the first prediction the data showed that subjects usually performed in accordance with the optimal strategy. The second prediction was also supported by the data; a blank resulted in a smaller SCR than a confirmation, which is inconsistent with Spence's (1970) hypothesis that blanks and confirmations have identical informational value. The differences in departure from the optimal strategy which turned up between blanks and confirmations can not be put forward, however, as evidence for Levine's thesis that the use of the optimal strategy is the same after blanks and after confirmations. Subjects violated the optimal strategy more often after blanks than after confirmations, although no significant differences turned up in TLE and NE. Furthermore, SCR after infirmation in the 67% condition turned out not to vary with the number of preceding confirmations, whereas this relationship did hold for the 100% condition. Perhaps the simplest way to consider these results is to postulate an inclination to lapse into a passive state after a blank, as done by Falmagne (1970) and Aiken et al. (1972), in which the subject is more apt to respond by chance, while this has no effect on the learning process per se.

The number of subjects solving the problems, TLE and NE showed a difference between tasks; a conjunction (TT) was easier to learn than an exclusion (TF) and a joint denial (FF). The difference between TT and FF is in accordance with findings by Haygood and Bourne (1965). TF and FF did not differ, however. This may have been caused by the criterion used; the maximum number of trials was perhaps too small for such a difference to show up.

The SCR data did not show a difference between TT, TF and FF. This lack of difference in SCR between tasks was predicted from the hypothesis that SCR primarily reflects uncertainty reduction and not information-processing activities during a concept learning task. The lack of difference cannot be explained by the habituation effect, because comparing SCR for equal numbers of trials of the tasks also yielded no significant differences between tasks.

The hypothesis that SCR is primarily an index of uncertainty reduction is further evidenced by two other results. Firstly, an increasing number of confirmations preceding infirmation resulted in an increase of SCR. This finding replicated the finding of De Swart and Das-Smaal (1976), and is in agreement with Sokolov's (1969) model of the orienting reflex, as well as with Trabasso and Bower (1968) and Falmagne (1970). Secondly, SCR turned out to be lower after blanks than after confirmations, while infirmations resulted in the largest SCR values.

Given that subjects employ a hypothesis testing strategy to identify the concept, it is evident that after each confirmation confidence that the true hypothesis is selected increases. Furthermore, after an infirmation the subject is certain that the selected hypothesis is wrong. In the case of blanks the prior probabilities are not changed. It is easy to show from Bayes' theorem that in a deterministic concept learning task the mean change in confidence (probability) at confirming feedback is always smaller than the mean change at infirming feedback, if the conditional probability of a confirmation, given the subject has the wrong hypothesis in mind, exceeds 0.50. In the present experiment the value exceeds 0.50 in each task. So, Bayes' theorem predicts the same order of changes in confidence as was found in the SCR data.

By using blanks, a parsimonious habituation explanation of the results of De Swart and Das-Smaal (1976) and of the present study is avoided. In both studies the number of confirmations was higher than the number of infirmations, hence the differences in SCR values could have been caused by a difference in likelihoods. In the present study the number of confirmations exceeded the number of blanks, which in turn exceeded the number of infirmations. A habituation explanation would predict in such a case lower SCR values after confirmations than after blanks. The opposite order was, however, obtained in the present study.

With respect to the effect of practice the data showed (1) that, in the majority of cases, subjects performed in accordance with the optimal strategy 'reject hypothesis only after infirmation'; (2) that solving the first problem resulted in some positive transfer, resulting in a more consistent usage of the optimal strategy in the two succeeding problems. Hence, practice turned out to result in positive transfer, which was independent of the task. This result is in accordance with Coltheart's suggestion (1973) and with White (1974). Coltheart, however, found a higher percentage of inconsistencies, which was mainly caused by the inconsistencies after confirmation. This is in contrast with the present data, which revealed a higher degree of consistency throughout the experiment as well as the lowest percentage of inconsistencies after confirmation. This difference in results may have been caused by differences in experimental set-up: (1) in Coltheart's study subjects had to learn an affirmation; (2) the number of confirmations and infirmations may have been different for the two studies; (3) Coltheart's feedback evaluated the response; in the present study the actual category was shown. It is unlikely that the difference was caused by a difference in stimulus population, for the same tendency was found by De Swart and Das-Smaal (1976) who, like Coltheart (1973), employed four two-valued dimensions.

Dominowski's finding (1973) that overt verbalization of the hypothesis leads to more efficient use of the available information was not replicated in the present study; no overall differences between verbalization and non-verbalization were demonstrated for any of the dependent variables. This agrees with Karpf and Levine (1971), who did not find a difference between Levine's blank procedure and verbalization of the hypothesis by the subjects. However, the possibility remains that an opposite tendency was working. It can be argued that, as a consequence of having to verbalize a hypothesis, the subjects were inclined to use a suboptimal part-scanning strategy instead of the optimal wholist or focussing strategy (Bruner et al. 1956), whereas they may have employed a more optimal strategy in the case of non-verbalization. In the present study as well as in the study of De Swart and Das-Smaal (1976) subjects used a suboptimal strategy. They stated a two-valued concept every time, although they were not explicitly instructed to do so. If both this and Dominowski's suggestion (1973) hold, no difference between the V and $\bar{V}$ condition needs to show up, because the two opposite tendencies could have neutralized each other. Hence, the present study did not offer a critical test to evaluate Dominowski's suggestion (1973).

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